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Results of the Observations made by the Rev. Fearon Fallows at the Royal Observatory, Cape of Good Hope, in the years 1829, 1830, 1831. *Reduced under the superintendence of G. B. Airy, Esq., Astronomer Royal.*

The Astronomer Royal commences his memoir with a historical introduction, in which the origin and progress of the principal British Southern Observatory are fully developed. The official papers preserved at the Admiralty have been carefully examined, by permission of their Lordships, and the minutes of the Board of Longitude are kept at the Royal Observatory for safe custody.

On the 3d February, 1820, and at a full meeting of the Board of Longitude, Mr. Davies Gilbert proposed, and Sir Joseph Banks seconded the proposal, that the Board should take into consideration "the propriety of establishing an Observatory at the Cape of Good Hope." This was acceded to, due inquiries were made, the proper official steps taken, and, finally, the Observatory was founded by an Order in Council, dated 1820, October 20.

The instruments were ordered from the following artists:—A 25-feet zenith sector, by Mr. Troughton (which was never begun); a 10-feet transit, by Mr. Dollond; and a 6-feet mural circle, by Mr. T. Jones. The personal establishment consisted of

One Astronomer at 600*l.* per annum.
One Assistant, 250*l.* ditto.
One Labourer, 100*l.* ditto.

And on October 26, 1820, the Rev. Fearon Fallows, M.A., Fellow of St. John's College, Cambridge, was appointed as astronomer. A sketch of a plan for the Observatory was prepared by Mr. Rennie, with the aid of Mr. Fallows, after consulting Messrs. Pond, Troughton, &c., which was approved of on February 1, 1821, when "a plan in detail" was ordered. On the 4th of May, 1821, Mr. Fallows set sail for the Cape, and arrived there on August the 12th.*

After a very extensive and careful survey of Cape Town and its neighbourhood, Mr. Fallows selected the site on which the Observatory now stands. He had abundant difficulties and annoyances to complain of, and there seems to have been some unnecessary delay in sending over the plans for the building. Unfortunately the portable instruments taken out by him were of very moderate pretensions, and thus the labour of some years was rendered comparatively useless. The large instruments did not arrive till December 1826, and the Observatory was not in a state to receive them till 1828. In 1829 the astronomical work commenced in earnest. The transit instrument was soon found to deserve perfect confidence, but the mural circle gave infinite trouble and vexation. Indeed a mystery hung over this instrument until after its return to England, when it was thoroughly examined by Mr. Simms, under the direction of the Astronomer Royal. After suffering for some time from bad health, Mr. Fallows died 1831, July 25.

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* There is a brief sketch of Mr. Fallows' life in the Report of the Council of the Royal Astronomical Society, *Memoirs*, vol. v. p. 404.

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By the kindness of Professor Charles Piazzi Smyth (formerly assistant in the Cape Observatory) Mr. Airy has been enabled to give a ground-plan of the Observatory.

After this historical account the Astronomer briefly states the contents of the MSS. which have been submitted to him, and the processes of verification and reduction.

The transit observations extend from April 11, 1829, to March 30, 1831. There are three copies, but apparently not one, strictly speaking, an original. Mr. Airy has adopted as his authority that called by Mr. Fallows the "third or clean copy."

The transit instrument is that still in use at the Cape Observatory, which is described by Mr. Maclear in the *Cape Observations* for 1834. Its focal length is 10 feet, aperture of the object-glass, 4·9 inches, with seven wires. Mr. Fallows observed only on the five middle wires (except by mistake), and his books are ruled for only five wires. This excellent instrument is the work of Mr. Dollond.

The distances of the wires have been carefully examined, and, in a few instances, the observations corrected by an alteration of one or more seconds. A few observations have been rejected.

Mr. Fallows has always given the mean of the five wires, when fully observed, in a separate column; in order to obtain the necessary data for the imperfect transits, 87 transits of β *Hydri* have been employed to compute the intervals of each of the five wires. For the extreme wires Mr. Airy has adopted the intervals determined by Mr. Maclear (see *Cape Observations*, 1834), the wires being the same for both observers.

The error of collimation, which is first to be determined, appears from Mr. Fallows' notes to have been as nearly as possible annihilated by adjustment, when necessary; this, however, was exceedingly seldom. It is evident, from the data adduced, that the instrument was very firm, and that no perceptible error is introduced by assuming, with Mr. Fallows, that the error of collimation and error in the form of the pivots may be neglected.

The level was frequently applied, and the level error deduced by Mr. Fallows was applied by him to the observations in the course of reduction up to March 31, 1830. These level corrections have been tested, and the mistakes rectified. After the date mentioned, the level errors are so small as to be insensible, and have been neglected.

Mr. Fallows appears to have determined his meridian mark very carefully by repeated observations of β *Hydri*, and to have relied upon the mark *only* for observations after March 1830. The corrections for azimuthal deviation have been applied by him to the earlier observations, and these have been examined and corrected, when necessary, by the observations of β *Hydri*. There are not sufficient astronomical data for determining the deviation after the date mentioned, and it has been assumed that there was no sensible error, as was evidently supposed by Mr. Fallows.

After applying these corrections, the time by the clock of the transits over the meridian was obtained.

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The next step was to deduce the clock error. Mr Fallows had followed the plan employed by Maskelyne, viz. to assume approximate right ascensions of certain bright stars (*α Orionis*, *Procyon*, *α Aquilæ*, and occasionally *Spica*), with one of which each star was compared, reserving the determination of the correct right ascension of the fundamental star until he should have reduced his observations of the equinoxes. This method was perhaps justifiable at that time, when there was no very exact recent catalogue of authority in existence. The case is now altered, and Mr. Airy has determined the clock errors, rates, &c. almost exactly as in the Greenwich Planetary Reductions, using Bessel's Catalogue for 1830, contained in the *Tabulæ Regiomontanæ*. Where these were insufficient, other stars were taken from Pond or from Piazzi, which were brought up by the corresponding precession, and by proper motion deduced from a comparison with Bradley.

The clock errors being thus found, were divided into 352 groups, each group being usually the result of a day's observation, and from these a rate was concluded for each group. Finally, a fictitious clock error for 0^h was found, as in the Greenwich practice. The clock appears to have gone well.

The clock error at 0^h, and the proportional part of the clock rate, were then applied to every clock time of transit over the meridian, and thus an apparent right ascension, as given by observation, was found. But no result was retained for a clock star, unless there were at least three clock stars in the group.

Mr. Fallows had completed the reduction of the apparent to mean places for nearly all the stars as far as March 31, 1830. The results only, however, are given, and hence it became necessary to check and verify them, which was accordingly done. For the stars not reduced by Mr. Fallows, corrections were computed for every separate determination by the constants of Bessel, &c.

The mean places of the stars from observation having been thus found for the beginning of the year of observation, those which were observed in 1829 or 1831 were reduced to 1830 by the application of a year's precession, and thus the ledger of results in right ascension for every separate observation of the stars was completed.

Having thus explained the reduction of the Transit Observations, which form the principal part of Mr. Fallows' MSS., Mr. Airy proceeds to a description of the process followed in reducing the Circle Observations. Of these there is one copy, commencing April 2, 1830, and terminating March 30, 1831, but though the book is entitled *Extracts from the Mural-Circle-Book of the Royal Observatory, Cape of Good Hope*, it probably contains *all* the observations made.

In a note, Mr. Fallows gives a short history of the circle from its arrival at the Cape to its final erection. He mentions that Captain Ronald had reported to him a slight fall of the package while raising from the hold, but he warrants the instrument having been free from any injury *after* that time.

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The strange anomalies in the divisions of this circle have been alluded to and examined by several persons.* In 1840 it was sent to Greenwich, and after some examination of its large pivot, which was evidently deformed, Mr. Simms, under the directions of the Astronomer Royal, proceeded to re-turn it, when, to the great astonishment of both, the steel collar of the pivot was found quite loose, having been attached merely by soft solder. A new collar was mounted in the usual way, by *heating on,* which was carefully turned, and the instrument adapted to use. The reader will see from the details of the Observations (See Greenwich *Observations* for 1848) how large the errors of division are, when freed from sensible error in the form of the pivot.

Mr. Airy adds that "there is not the smallest appearance of mechanical injury to the instrument," and conceives that probably the first cause of the discreditable state of the divisions is the form of the pivot, by which, in Troughton's mode of division, unless checked by opposite readings, every division must have been affected. It is satisfactory to learn that Mr. Airy's use of the instrument has satisfied him of the correctness of the opinions of Messrs. Fallows, Henderson, and Maclear, viz. that the *mean* of the *six* microscopes may be fully relied on.

The first examination of the observations was for the purpose of detecting such erroneous readings of microscopes as do not exceed a few seconds, and also errors of 1′, which, in this instrument, may easily occur. Several errors in the readings of microscopes and in means, which had escaped Mr. Fallows, were thus detected. Mr. Fallows' practice was to observe stars on successive days, alternately by direct and by reflected vision; a perfectly legitimate method if the instrument preserves its adjustments accurately. To obtain the zenith points, Mr. Airy applied the corrections for refraction, and also the corrections to the mean place, to the observations in the first instance. The observations were now such as would have been made if there were no refraction, and the stars were in their mean places. Then, by comparing a direct circle-reading, thus corrected, of a star one day, with a reflexion circle-reading, similarly corrected, of the same star next day, a zenith-distance point was found. These partial zenith-distance points were found to be exceedingly accordant, and so steady from day to day that the same value sufficed for a considerable group. The mean zenith distances thus found were converted into mean north polar distances, using Mr. Henderson's colatitude, which is nearly the same with that which is deduced from Mr. Fallows' observations of β *Hydri.*

The results thus obtained were finally combined in a catalogue, using the nomenclature of the best known catalogues as a basis. The annual variations are taken from the Catalogue of the *Royal*

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* See *Memoirs of the Royal Astronomical Society,* vol. v. for a paper by Mr. Sheepshanks, with additional remarks by Mr. Airy; vol. viii. for a notice by Mr. Henderson. Mr. Maclear made a very extensive and laborious series of measures, from which he deduced the errors of the divisions.

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Astronomical Society when the stars occur there. For other stars the precessions are computed from the following formulæ :—

$$\text{R.A.} = +3^{\text{s}}{\cdot}068 + 1^{\text{s}}{\cdot}3362 \times \sin \text{R.A.} \times \text{cotan N.P.D.}$$
$$\text{N.P.D.} = -20''{\cdot}043 \times \cos \text{R.A.}$$

The observations of the sun, moon, and planets, present no peculiar difficulty, as the instrumental corrections were already determined ; the observations are treated nearly as such observations are treated in the Greenwich Volumes.

The North Polar Distances of the Comet of 1830* are given as computed by Mr. Fallows with index-errors concluded from observations of *α Orionis* and *α Hydri.* Refraction is applied, but not parallax. Some additional observations were made of this Comet with an altitude and azimuth circle, and some measures of the distance of the cusps in the Solar Eclipse in the same year. These are not reduced, as some essential explanations are wanting.

A Method of Correcting the Errors due to the Forms of the Pivots of a Transit Instrument. By Professor Challis.

The method proposed by the author requires the solution of the following problem :—Having drawn from a selected point of the middle wire of the telescope, situated near where the transits are usually taken, a straight line to the optical centre of the object-glass, it is required to find, independently of the forms of the pivots, the small angle made by this line with the plane of the meridian for any position of the telescope. The solution of this problem may be effected by employing Bohnenberger's collimating eye-piece, in conjunction with the method of measuring by micrometer-microscopes the positions of two dots at the extremities of the pivots, first suggested by the Astronomer Royal and applied by him in testing the forms of the pivots of the new altitude and azimuth instrument at the Greenwich Observatory. The collimating eye-piece gives the angle (α) which the line of collimation makes with the meridian plane when the telescope is directed to the nadir. If y_1 y_2 be the vertical microscope readings for bisections of the dots in this position of the telescope, y'_1 y'_2 be the vertical microscope readings, and x'_1 x'_2 the horizontal microscope readings for bisections of the dots, when the telescope is pointed to an angular distance, z, from the zenith southward, and ξ be the small angle required, then

$$\xi = \alpha + \frac{y_2 + k - y_1}{\text{D}} + \frac{y'_2 + k - y'_1}{\text{D}} \cos z + \frac{x'_1 - x'_2 - h}{\text{D}} \sin z,$$

D being the distance between the dots, and h and k certain constants, by means of which the readings of the two microscopes are

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* Some particulars of this Comet will be found in the *Astronomische Nachrichten,* N. 183 ; vol. viii. p. 300.